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THERMAL CONDUCTIVITY OF PAX 2A EXPLOSIVE BY DSC

Joel Harris

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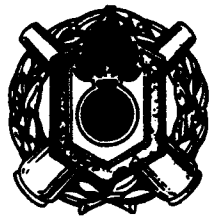

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A technique to determine the coefficient of thermal conductivity by Differential Thermal Calorimetry (DSC) was developed. The thermal conductivity for teflon (polytetrafluoroethylene), high melt explosive (HMX), and PAX-2A explosive were determined. The thermal conductivity values determined for teflon and HMX agree with those found in literature; whereas, the value for PAX-2A was determined to be $14.26 \pm 0.26 \times 10^{-4}$ calories/cm-s-°C.

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CONTENTS

OBJECT

To determine coefficient of thermal conductivity of explosive PAX-2A.

INTRODUCTION

Thermal conductivity is a parameter of energetic materials which is required in order to do determinations of critical temperatures and ballistic calculations. In the past, before the existence of Differential Scanning Calorimeters (DSC), large test samples were required. Such procedures which involve large samples were both hazardous and time consuming. The DSC method requires only a 1/4 in. pellet of material and only a few hours time depending on time spent in calibration and repetitive experiments. The method makes use of a Perkin-Elmer DSC-2, although any DSC type instrument would do.

EXPERIMENTAL PROCEDURE

The apparatus for thermal conductivity measurements appears in figure 1. The temperature at the bottom of the pellet is measured by a calibrated resistance wire attached to the sample holder of the DSC cell. Since the DSC cell consists of two cells, the instrument sends power into the cell with the pellet in order to equalize the temperature in both cells. The power is equal to the energy being conducted away by the pellet and proportional to the thermal conductivity of the pellet. A thin layer of conductive grease is rubbed on the bottom and top of each pellet to ensure good thermal contact. A copper fuse cup on top of the pellet conducts the heat to a copper-constantan thermocouple through an insulator in order to measure the temperature at the top of the pellet. The power surge is measured as a deflection on a Perkin-Elmer 056 two pen recorder. The other pen records the millivolt response from the thermocouple.

RESULTS

The data from the above measurements (deflection and temperatures) are fitted into the following equation

$$k = \frac{dq/dt \times L}{A \times (T_1 - T_2)}$$

as derived in reference 1 and compiled in table 1.

k= Thermal conductivity at test temperature (10^{-4} cal/cm sec-°C)

dq/dt= Heat flux cal/s (deflection mcal) X DSC range (mcal)

L= Length of pellet (in.)

A= Area of pellet surface (in.)

$T_1 - T_2$ = Temperature difference °C

Results from other sources are also included in table 1 for high melt explosive (HMX) and teflon (PTE).

DISCUSSION OF RESULTS

There is generally a paucity of thermal conductivity data in the literature. Values found for PTE vary with the method used. Values found in references 2 through 4 appear similar to values in table 1. The value found for HMX with 0.5 % wax in the table compares favorably with the values for HMX listed in reference 5, although the HMX pellets in the two reports have different densities.

CONCLUSION

A Differential Scanning Calorimeter Instrument can be used to accurately determine the thermal conductivity of 1/4 in. pellets of materials.

Table 1. Thermal conductivity data

MATERIAL		DENSITY	AVERAGE THERMAL CONDUCTIVITY	TEMPERATURE OF TESTS	NO. OF TESTS	REFERENCES
		GM/CC	K [A]	°C		
PTE [1]	TEFLON	2.154	9.85±0.05	40	3	EXPERIMENTAL
PTE [1]	TEFLON	2.154	9.50±0.30	42	4	EXPERIMENTAL
PTE [1]	TEFLON	2.154	10.23 ± 0.43	60	6	2
PTE [1]	TEFLON	2.154	9.54 ± 0.42	100	6	2
PAX-2A [2]	W/O GRAPHITE	1.78	14.26±0.47	40	5	EXPERIMENTAL
PAX-2A [2]	W GRAPHITE	1.78	14.26±0.26	40	5	EXPERIMENTAL
HMX+0.5%WAX		1.65	10.81±0.80	40	5	EXPERIMENTAL
[3] HMX		1.91	9.83-13.3			5

[1] Polytetrafluoroethylene (teflon)

[A] 10^{-4}(calories/cm.-sec-°C)

[2] 85 HMX + 9 BDNPF/A + 6 CAB [4]

[3] cyclotetramethylene tetranitramine

[4] cellulose acetate butyrate

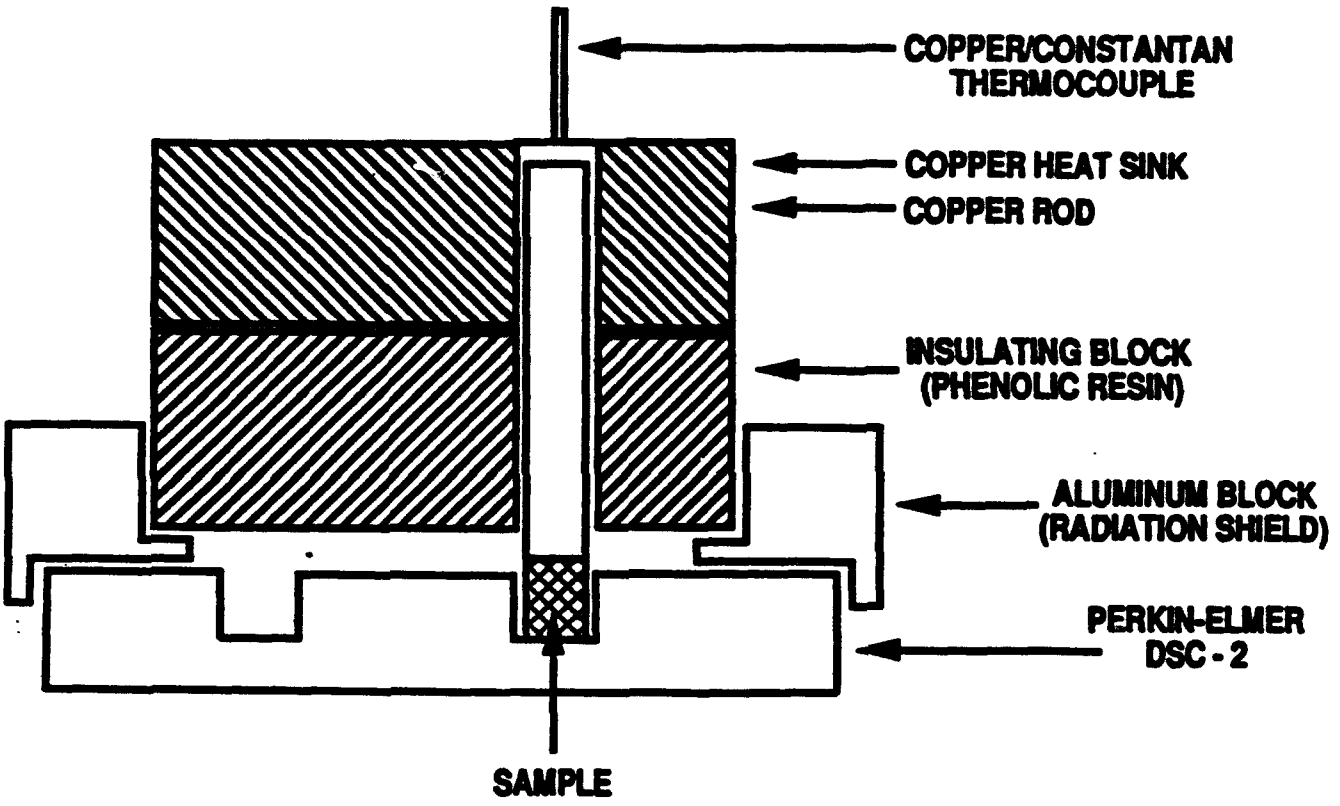

Figure 1. Thermal conductivity accessory

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